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14. ABSTRACT

The Naval Research Laboratory's (NRL) Geospatial Information Database (GIDB) Portal System is a standards-based portal for geospatial information discovery, access and mapping over the Internet. The system has proven to be a powerful tool for gathering heterogeneous environmental data from disparate databases distributed across the Internet. Information is displayed in a "GIS like" fashion for data overlay and comparison using NRL's or other popular viewers. Data can be exported in several formats for use in analysis packages. The technology is being used in the new Tactical Environmental Data Services (TEDServices) architecture.
The portal system was developed in Java for platform portability. Its components include a downloadable thick client, a Web browser-based thin client, a PDA client and a flexible, plug-in server architecture (implemented as a Java servlet) that can allow data of any origin to be distributed to the clients. An open source, all Java object-oriented database management system, called Ozone, is also available for deployments requiring custom data storage.
The GIDB Portal System presently connects the user to nearly 300 Services and 50 Servers across the U.S. The system is government-owned and requires no licensing. The GIDB Portal System is area-of-interest and theme-of-interest driven for ease of use (from a neighborhood-level to country or world resolution).
This Portal System technology has been under development at NRL for the past nine years with support from multiple sponsors including ONR, NRL, NIMA and SPAWAR. These efforts have culminated in an advanced portal system that is being used operationally by several programs.
The U.S. National Guard Counter Drug Program is currently using a version of the GIDB Portal System technology as the basis for their Digital Mapping Server (DMS) Portal in supp

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Access to Environmental Data Via NRL's Geospatial Information DataBase

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Abstract

The Naval Research Laboratory's (NRL) Geospatial Information Database (GIDB) Portal System is a standards-based portal for geospatial information discovery, access and mapping over the Internet. The system has proven to be a powerful tool for gathering heterogeneous environmental data from disparate databases distributed across the Internet. Information is displayed in a "GIS (Geographic Information System) like" fashion for data overlay and comparison using NRL's or other popular viewers. Data can be exported in several formats for use in analysis packages. The technology is being used in the new Tactical Environmental Data Services (TEDServices) architecture.

The portal system was developed in Java for platform portability. Its components include a downloadable thick client, a Web browser-based thin client, a PDA client and a flexible, plug-in server architecture (implemented as a Java servlet) that can allow data of any origin to be distributed to the clients. An open source, all Java object-oriented database management system, called Ozone, is also available for deployments requiring custom data storage.

The GIDB Portal System presently connects the user to 128 servers including over 800 services across the U.S. The system is government-owned and requires no licensing. The GIDB Portal System is area-of-interest and theme-of-interest driven for ease of use (from a neighborhood-level to country or world resolution).

This Portal System technology has been under development at NRL for the past nine years with support from multiple sponsors including ONR, NRL, NIMA and SPAWAR. These efforts have culminated in an advanced portal system that is being used operationally by several programs.

The U.S. National Guard Counter Drug Program is currently using a version of the GIDB Portal System technology as the basis for their Digital Mapping Server (DMS) Portal in support of counter drug agents and agencies. This technology is also in use at NIMA's Gateway SIPRNET site allowing the dissemination of local file system information at the NIMA Gateway as well as integrating that information with multiple other non-NIMA sources. The GIDB technology is being transitioned in FY 04 as the next generation delivery mechanism for oceanographic, meteorological and environmental data to the U.S. Navy through the SPAWAR PMW-155 program Tactical Environmental Data Services (TEDServices).

Background

Environmental data must be collected, stored and made readily available to users. Many types of environmental data are needed to support naval operations, especially in the littoral. As an example bathymetry is required for safe navigation, circulation models, mine warfare tactical decision aids, acoustic propagation models, wave and surf

forecast models, tide models and many others. During operations and exercises high resolution real-time data is needed to verify and supplement historical holdings. Technology developed under the Geospatial Information DataBase (GIDB™) is one solution to the dissemination, storage and connectivity challenges involved with linking environmental data from multiple sources to multiple users.

The Naval Research Laboratory's (NRL) Mapping Charting and Geodesy Branch's interest in Object Oriented database approaches began in 1991. The National Imagery and Mapping Agency (NIMA) established Vector Product Format (VPF) as the digital standard for disseminating their mapping and charting data. Under tasking from the Oceanographer of the Navy, NRL found the format chosen for the data model cumbersome and less than optimal; however, better data models did not exist.[1] An Object Oriented (OO) data model was proposed, and in 1994 NRL developed an OO prototype of the Digital Nautical Chart, a complex VPF product, for NIMA. This successful effort led to the development of several other object models and eventually Object VPF. Subsequently object models were also developed for raster and text products. CORBA and JAVA were introduced the following year and NRL developed an Extended VPF OO model to represent terrain data in three dimensions for the modeling and simulation community. By 1997 CORBA 2.0 was a stable standard, JAVA became the OO programming language of choice, and NRL began working on web-based digital mapping capabilities leading to the GIDB.

GIDB

GIDB is an object-oriented, CORBA-compliant spatial database that supports remote access and analysis of complex spatial data via a Java Applet over the internet.[2] Users can query the database by area-of-interest, time-of-interest, distance and attribute. The database component of GIDB is an Open Source, all-Java, OO-database management system called Ozone.[3] Data is stored into a common OO-data model designed to retrieve data in a mapping context in terms of scale, thematic layers, and feature classification types. GIDB is able to store data from multiple sources including NIMA, the Naval Oceanographic Office, the U.S. Geological Survey, the National Ocean Survey, the U.S. Census Bureau, and the U.S. Army Corps of Engineers. Most data is stored in either VPF format or ESRI's Shapefile Format.

Distributed Database Portal

Storing all mapping data in a single database is impractical. With the introduction of the GIDB portal, the system has moved from a monolithic database to a truly distributed database system able to connect and retrieve data from disparate databases in addition to the GIDB Ozone database. The portal establishes a common data request format and a common data transfer format. As a result the GIDB portal allows retrieval of data from existing data repositories regardless of whether they are relational databases, hybrid systems or pure OO-database management systems (OODBMS).[4] Translation of data from its native format to the common data transfer format occurs in the portal. The portal is made up of many drivers, one written for each new format, and each providing a common interface between the data source and the GIDB system. The GIDB portal makes details of data translation transparent to the user.

New Technology and Standards

GIDB success has been based on its ability to take advantage of new technology and standards. The OO database design provides for topological support among coverages, non-duplication of features (points, lines or areas) among coverages, improved data update and increased access speed. Ozone was chosen as the OODBMS for GIDB because it is open-source which provides distinct advantages including: access to source code to customize the database; and no licensing fees.[5] Object Management Group's CORBA (Common Object Request Broker Architecture) standard is used to specify the middleware architecture for distributed object communication between client and server. CORBA is the communication element that handles messages between objects, converts parameters to common data types, and serves as a translator between different programming languages. The standard language is Java. Java is the object-oriented programming language embeddable in internet web pages. Java programs are commonly called applets. GIDB's Web Mapping Toolkit is written in Java using CORBA standards. This architecture gives a user (client) access to a plethora of map data using a standard web browser.[6] GIDB also uses XML-based standards to expand its mapping portal capabilities. XML (eXtensible Markup Language) is a World Wide Web Consortium Standard designed for internet use.[7] XML allows users to define the data types of information (ex: conductivity, temperature, depth) and include the semantic data type (ex: temperature) information in the same file as the data itself (ex: 85, 92, 77). Using XML catalogs GIDB can determine what data is available and how to retrieve it. Adhering to these standards, GIDB supports VPF products, raster imagery, shape file format, video clips, audio clips, temporal data, and industry standards.

User Interfaces

NRL has developed several user interfaces for the GIDB including a simple Web-based Java Thin-client, a more sophisticated application (Thick-client) that can be downloaded, a PDA client, and a plug in. NRL's viewers let a user select data by location, area-of-interest, or theme. The Thick-client allows multiple layers of information to be viewed simultaneously and includes a growing number of tools to adjust transparency, zoom from a world view down to a neighborhood area, measure distances, change colors, mark addresses, perform spatial queries, and other mapping functions. Figure 1 shows a screen capture from the Thick-client. Data can be exported in several formats including Shape-File, and VPF. Because GIDB is standards based the viewer can be replaced with a commercial one like ESRI's Arc-View or a custom viewer. GIDB connectivity between client and server functions normally with data simply supplied to a different viewer interface with its particular set of mapping tools.

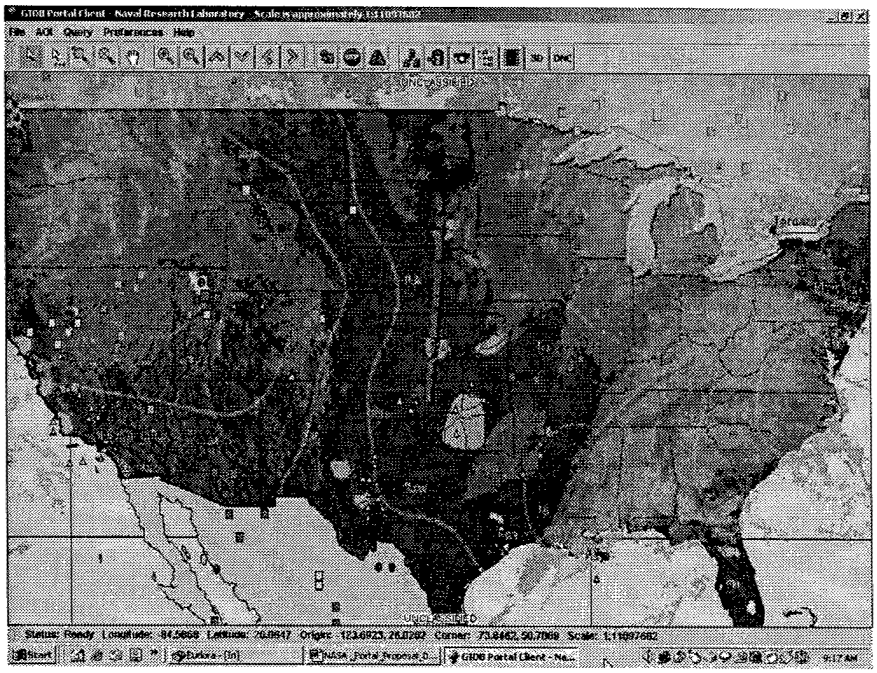

Figure 1.
A sample GIDB Portal System Thick-client display showing integrated cloud cover, meteorological information, mineral locations, and other sources.

TEDServices

Portions of the GIDB technology are being used in SPAWAR's Tactical Environmental Data Services (TEDServices) program to deliver critical environmental information to sailors, weapon systems and MetOc data users. TEDServices provides the middleware infrastructure to transport and transform environmental data. Following guidance established by the Navigator of the Navy, data complies with the WGS84 datum and universal time coordinate standards. The Oceanographer of the Navy established a concept of operations to ensure the best data gets to the user. In that concept production centers (ex: the Naval Oceanographic Office, and the Fleet Numerical Meteorological and Oceanographic Center) generate atmospheric and ocean model predictions based on in-situ data. Domain Authorities (environmental data experts) examine data from multiple sources, merge it and resolve conflicts in the predictions with other information to generate a Virtual Natural Environment (VNE). Centers of Expertise (warfare area experts) use the VNE in automated tactical decision aids (TDA) to make judgments on the ability to perform certain operations and determine a measure of risk imposed by the environment. Remote users afloat or ashore can examine the products from both the Domain Authorities and the Centers of Expertise before conducting operations.

Bandwidth Savers

TEDServices incorporates several procedures and new developments to compensate for the diminishing bandwidth between production center and user. The first is a VNE data cache that is forward deployed to respective components. Next, to minimize the amount of data passing over the network, TEDServices Clients use a MetOc/Mission Rules Based Data Order (MRBDO) process to subscribe only to relevant

data by mission, platform, parameter, application or product. This function is complemented by a Local Data Broker (LDB) that minimizes reach back requirements. The LDB knows what data is stored locally, and how to contact other TEDServices GateWays to request just the needed products in their area of interest. For large data transfers TEDServices employs Resumable Object Streams (ROS) for all traffic between major components. In the event of a loss of network connection by either the client or server, ROS knows how much data was transmitted. When the network comes back up, ROS continues data transfer where it left off. Retransmission is not required. At the user end a development called Collaborative Application Sharing (CASP) allows remote application users to share the "state" of their applications across the internet. For instance an expert at a Center of Expertise can use the VNE in a TDA to arrive at a particular decision and share only the settings on his machine with a remote user. The remote user receives only the "state" of the expert's application and uses that information in his local VNE and TDA to examine the results with a minimum of data transfer.

USERS

GIDB technology is supporting a growing number of users. TEDServices, described above, is the U.S. Navy's primary user of the technology for distributing critical environmental data. Communications are bi-directional and the design follows the Chief of Naval Operations concept of operations for ensuring that the best de-conflicted environmental data reaches the user.

The U.S. National Guard Bureau's Counter Drug Office uses the portal to support drug and law enforcement agencies across the United States with a one-stop web site for geospatial information. This system was designed in collaboration with the Intelligence Department of the Head Quarters Marine Corps. The portal, which has no data in it per se, is currently linked to over 128 servers representing over 800 services nation wide. These sources of geospatial information generally represent information in the continental United States, selectable by area of interest. Data can be viewed, printed as a map or used in PowerPoint presentations. User documentation is provided.

The National Imagery and Mapping Agency (NIMA) hosts a classified version of the GIDB Portal at the NIMA Gateway in Missouri. The Naval Oceanographic Office also hosts SIPRNET versions of the GIDB technology to support tactical decision aids.

Exercises supported

GIDB technology has been used in many fleet and national exercises to demonstrate its capabilities. In the spring of 1999 the Marine Corps used GIDB to support Exercise *Urban Warrior*. This exercise demonstrated remote updating of Digital Nautical Chart onboard a ship at sea, and the use of three-dimensional representations of urban environments to train and track assault troops. GIDB supported *Fleet Battle Experiment Hotel* in July 2000 demonstrating near real-time creation and use of Mission Specific Data Set environmental overlays on Digital Nautical Chart. Exercise *Millennium Dragon*, September 2000, used GIDB technology to provide map objects to the Marine command center, disseminate imagery from airborne surveys, and track vehicles in a simulated amphibious assault inland. The Marine Corps Warfighting Laboratory used the GIDB technology in February and June of 2001 to support Exercise *Capable Warrior* on the U.S. west coast during expeditionary warfare training. More

recently TEDServices supported a major anti-submarine warfare exercise, *Fleet Battle Experiment Kilo*, by providing critical environmental data. Supporting Homeland Defense, GIDB was used in the command center for the highly publicized *TOPOFF2* Exercise providing imagery, map and other geospatial information, to the top officials at city, county, state and national levels for decision making.

Conclusions

The GIDB provides connectivity to heterogeneous databases across the internet using portal technology. The portal establishes a common data format, and provides translation of data from native formats. GIDB uses CORBA standards, is written in JAVA for platform independence, and uses XML standards. Queries are made using a web based Thin-client or a more robust application, Thick-client. Data is easily accessed by area-of-interest, theme, location or by a specific database service.

Distribution and access to environmental data is simplified with GIDB's flexible approach to manage, store and assimilate real-time, historical and model output. Users of the technology include: the National Guard for law enforcement and counter drug operations; the U.S. Marine Corps for map services; the National Imagery and Mapping Agency for product dissemination; and the Navy uses the technology in TEDServices to disseminate environmental data needed to support tactical decision aids. GIDB environmental data distribution capabilities have been demonstrated in numerous exercises. GIDB is government owned, patent protected, and license-free.

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